Land Surface Modeling and Data Assimilation to Support Physical Precipitation Retrievals for GPM

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Abstract

Objective: The objective of this proposal is to provide a routine land surface modeling and data assimilation capability for GPM in order to provide global land surface states that are necessary to support physical precipitation retrieval algorithms over land. It is well-known that surface emission, particularly over the range of frequencies to be included in GPM, is sensitive to land surface states, including soil properties, vegetation type and greenness, soil moisture, surface temperature, and snow cover, density, and grain size. Therefore, providing a robust capability to routinely provide these critical land states is essential to support GPM-era physical retrieval algorithms over land.

Relevance: This proposal addresses primarily Category (1) of the NRA, which focuses on the development, evaluation and validation of TRMM and GPM retrieval algorithms. In particular, the proposal addresses element 1.1.3: Development, testing, and validation of radiometer retrieval algorithms over land, with emphasis on physically based techniques to extract precipitation information from measurements over the range of 10-183 GHz. The proposal also will address elements 1.3 (Error Characterization) and 1.5 (Improvement of GPM satellite simulators). The proposal also addresses Category (2) of the NRA, including topic 2.2: Use of satellite and field campaign data to evaluate and improve land surface and hydrological models and parameterizations.

Approach: The approach for this proposal is to enable the routine deployment of a PMM-customized instance of the Land Information System (LIS; http://lis.gsfc.nasa.gov), and make the output states available on the PPS prior to launching the GPM core. LIS is a flexible and highly-configurable land surface modeling and data assimilation software framework. As a land surface modeling component for earth system models, LIS has also been coupled to other atmospheric modeling components, most notably the Weather Research and Forecasting (WRF) model, which will be used with collaborator Wei-Kuo Tao to evaluate the role of land surface states in cloud and microphysical properties. In addition to these capabilities, LIS has also been demonstrated for parameter estimation and data assimilation. For this project, the global LIS output will be available on the same grid as the expected GPM level 3 products, and will support routine calculation of surface emission at microwave frequencies using a range of state-of-the-science approaches including the CRTM from NESDIS, and the SDSU from GSFC, as well as semi-empirical approaches from CSU. LIS can support multiple land surface models with varying complexity in their parameterization of vegetation, soil, and snow-pack processes. We will evaluate the accuracy of land surface states that are most sensitive for microwave emission calculations, and evaluate different approaches to land-state based emissivity correction with our collaborators, including Gail Skofronick-Jackson, Toshi Matsui, Marco Tedesco, Ralph Ferraro, Fuzhong Weng, and Chris Kummerow (and jointly advised Ph.D. student Sarah Finn). In addition to our own evaluations at various field campaign sites (e.g., C3VP, Finland, ARM/MC3E; HMT-West, and HMT-SE), we will also work with collaborators to evaluate the representation of the land surface states in variable terrain, including complex terrain (Dave Gochis, Mei Han), arid/West African (Karen Mohr), and snow (Marco Tedesco). These evaluations will help us focus on defining accuracy requirements for various surface emission approaches at various frequencies prior to GPM-launch, so that we may support routine land state estimation for physical retrievals over land.